

→ MAPPING URBAN AREAS FROM SPACE CONFERENCE

lass of the last



EO4CBI: Earth observation in support of the City Biodiversity Index

Stefan Kleeschulte space4environment

Concordia

4-5 November 2015 | ESA-Esrin | Frascati, Rome (Italy)

space 4 environment



• Urban population:

• Today > 50% globally & > 70% in Europe

2050 projections 66% globally





 Urban areas cover only 2-3% of the global surface, but consume about 75% of all resources

- Sustainable urban development
 - Cities need to re-think their approach to management and conservation of biodiversity









- Singapore Index on Cities' Biodiversity
 - Reply to a lack of indices to measure urban biodiversity
 - Proposal at CBD COP-9 in Bonn (2008), prepared by Singapore National Parks Board
 - Endorsed at CBD COP-10 in Nagoya (2010)
 - Support to Aichi Biodiversity Targets 2011 2020







Aichi Target bird data

Improve awareness of biodiversity Mainstream

biodiversity

3 Reform incentives 4 Implement plans for sustainability

> Reduce habitat loss and degradation

9 Tackle invasive species 10 Minimise climate change impacts

11 Protect and manage critical sites

6 Fish sustainably 7 Make farming and forestry sustainable 8 Reduce pollution

2

B. Reduce pressures and promote sustainable use Indicator

- Link between CBI and Aichi targets
 - Almost each Aichi target has one or more links to the CBI indicators (see Annex B in CBI User Manual)
- Link to the Sustainable Development Goals





CBI Framework



				SINGAPORE INDEX ON CITIES' BIODIVERSITY		
S S	truc	Location and and a	size (ge verage	tion (range		
PARKS		> Physical featu	es of ti			
PARKS BOARD SINGAPORE		5	l'a al ca			
		Demographics	(includ			
	Dout	5i	or une p	a (Cress Demostic Desclust (CDD). Cress National Desclust (CND) and emits increase law economic		
	Part	drive	rs and p			
	Profi	Biodiversity fe	atures rtance,			
	City	Administration	n of bio			
		🟅 are p	are protected (through national parks, nature reserves, forest reserves, secured areas, parks, etc.)			
		Links to relev	ant w			
	Опа	Core	II SIDIE I	or managing biodiversity	Mawimum	
	Scara	Components		Indicators	Score	J
		Native	1.	Proportion of Natural Areas in the City	4 points	
		Biodiversity	2	Connectivity Measures	4 points	
		in the City	3.	Native Biodiversity in Built Up Areas (Bird Species)	4 points	
			4	Change in Number of Vascular Plant Species	4 points	
			5.	Change in Number of Bird Species	4 points	
			6.	Change in Number of Butterfly Species	4 points	
			7.	Change in Number of Species (any other taxonomic group selected by the city)	4 points	
			8	Change in Number of Species (any other taxonomic group selected by the city)	4 points	
			9.	Proportion of Protected Natural Areas	4 points	
			10	Proportion of Invasive Alien Species	4 points	
		Ecosystem	11.	Regulation of Quantity of Water	4 points	
		o Services	12	Climate Regulation: Carbon Storage and Cooling Effect of Vegetation	4 points	12 - 4
		5 provided by	13.	Recreation and Education: Area of Parks with Natural Areas	4 points	licators
		Biodiversity	14.	Recreation and Education: Number of Formal Education Visits per Child Below 16 Years to Parks	4 points	
		τ.		with Natural Areas per Year		
		Governance	15.	Budget Allocated to Biodiversity	4 points	
		and	16.	Number of Biodiversity Projects Implemented by the City Annually	4 points	
		Management	17.	Existence of Local Biodiversity Strategy and Action Plan	4 points	
		₹ of	18.	Institutional Capacity: Number of Biodiversity Related Functions	4 points	licators
	5	Biodiversity	19.	Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co- operation Pertaining to Biodiversity Matters	4 points	licators
			20.	Participation and Partnership: Existence of Formal or Informal Public Consultation Process	4 points	
	UUU		21.	Participation and Partnership: Number of Agencies/Private Companies/NGOs/Academic	4 points	
				Institutions/International Organisations with which the City is Partnering in Biodiversity Activities.		
				Projects and Programmes		
	e)		22.	Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum	4 points	licators
			23.	Education and Awareness: Number of Outreach or Public Awareness Events Held in the City per	4 points	
				Year)
				Native Biodiversity in the City (Sub-total for indicators 1-10) 4	0 points	
				Ecosystem Services provided by Biodiversity (Sub-total for indicators 11-14)	6 points	
				Governance and Management of Biodiversity (Sub-total for indicators 15-23) 3	6 points	🕒 Dr. Lena Chan
			_	Maximum Total: 9	2 points	



CBI Factsheet - example

esa

Brussels comprises 19 municipalities spread over 162km². The capital has an oceanic climate ranging from 1°C (average of January) to 23°C (average of August), and receives an annual rainfall of 818mm. The temperate weather is greatly influenced by nearby wellands. Snowfall is rare, generally occurring only once or twice a year.

Brussels has a population density of 6,751 persons/km². Its highly educated population of 1,089,538 enjoys a GDP of EUR 66,672 million and a per capita GDP of EUR 60,861 in 2009. As Europe's centre of administration, Brussels' economy is largely service-oriented. It is dominated by regional and world headquarters of multinationals and European institutions, particularly in the financial sector.



NATIVE BIODIVERSITY

Despite its high population and infrastructural density, Brussels enjoys the reputation of being a green city, with 239ha of natural forest reserves and 1,735ha of forests. The city's 350ha of landscape parkland play a key role in Brussels' unexpectedly rich flora and fauna count; the native species count includes 578 plants, 92 birds, 28 butterflies and 39 mammals. The city's ecosystems include temperate forests, freshwater marshes, rivers and waterflows, wasteland habitats and natural grasslands.





Application of Singapore Index on Cities' Biodiversity

Restoration of Woluwe River

The Woluwe River straddles several municipalities in east and southeast Brussels. Intense urbanisation in the 1960s impacted a large part of the river, threatening habitats and native biodiversity. It was later restored in 1990 as part of the 'Blue and Green Network' programme, which aimed to connect green clusters and natural water bodies in Brussels.

Due to good water quality, effective ecological management of the river verges, and introduction of native water plants, the river has seen a repopulation of dragonflies, butterflies and water birds, e.g. kingfishers.



GOVERNANCE AND MANAGEMENT OF BIODIVERSITY

The Brussels Institute for Management of the The BE gives advice on plans or projects that possibly Environment (BE) oversees the city's biodiversity efforts. have impacts on biodiversity. It also supports NGOs' It is in charge of species and habitats surveys and activities on biodiversity and conduct public awareness monitoring alongside the management of 1,735ha of campaigns. forest and about 400ha of parks.

	1. Brussels has 3,308ha of natural areas, covering 20.4% of the entire city.										
	2. To be determined based on revised formula.										
	3. Baseline data (2010): a mean of 2,115 bird species can be found in built-up areas.	8									
2	4. Baseline data: 578 native vascular plant species.	<u> </u>									
5	5. Baseline data: 92 native species of breeding birds.	80									
	6. Baseline data: 28 native butterfly species.	ö.									
U	7. Baseline data: 8 native species of herpetofauna.	୍ଷ									
2	8. Baseline data: 39 native species of mammals.										
2	9. Brussels' protected land area comprises 14.4% of total land area.	Ž									
ñ	10. The proportion of alien invasive bird species as opposed to native bird species is 4.35%.										
5	11. Brussels has 54% of permeable areas.	Ę,									
b	12. Brussels' tree canopy constitutes 46.6% of total city area.	ste									
	13. Brussels provides 2.69ha of natural coverage per 1,000 persons.	S									
	 About 16,000 children benefitted from a specific awareness raising programme on nature in 2009. 	щo									
ja Li	 Brussels spends an average of 0.04% of its total budget on biodiversity administration and projects. 	ť									
	16. A total of 11 biodiversity projects were undertaken by the city and NGOs in 2010.	Ê									
Ż	17. Guidelines for promotion of biological heritage in the Brussels-Capital are in place.	8									
	18. Brussels has the following biodiversity-related institutions: Jardin Botanique Jean Massart, KBIN museum, Duvignaud Library, Vrije Universiteit Brussel, Universitei libre de Bruxelles and INBO research centres.										
5	 There are 10 municipal or local government agencies involved in biodiversity-related inter-agency cooperation. 										
ĥ	 Public consultation processes are systematic for all plans or projects that possibly have a significant impact on biodiversity. 	e									
2	21. Brussels works with 27 organisations and NGOs on biodiversity programmes.	l ar									
	22. Biodiversity or elements of it are included in Brussel's school curriculum.	OVe									
	23. Brussels conducted 576 (394 regular and 182 unique) public awareness events in 2009.	G									
L	22. Biodiversity or elements of it are included in Brussel's school curriculum.										







Application of the index

- x esa
- Self-assessment tool, not for comparisons between cities as context is key to performance
- Helps cities to accomplish their biodiversity goals by ...
 - Creating a baseline that supports the identification of policy priorities and can be monitored over time
 - Serving as public platform (biodiversity awareness raising)
 - Acting as collaboration portal between different stakeholders



Project objectives



- Since its establishment, the number of participating cities remained limited → lack of data, personnel and GIS skills
- EO4CBI provides support for four of the indicators:

Native	1.	Proportion of Natural Areas in the City
Biodiversity	2.	Connectivity Measures
in the City	3.	Native Biodiversity in Built Up Areas (Bird Species)
	4.	Change in Number of Vascular Plant Species
	5.	Change in Number of Bird Species
	6.	Change in Number of Butterfly Species
	7.	Change in Number of Species (any other taxonomic group selected by the city)
	8.	Change in Number of Species (any other taxonomic group selected by the city)
	9.	Proportion of Protected Natural Areas
	10.	Proportion of Invasive Alien Species
Ecosystem	11.	Regulation of Quantity of Water
Services	12.	Climate Regulation: Carbon Storage and Cooling Effect of Vegetation
provided by	13.	Recreation and Education: Area of Parks with Natural Areas
Biodiversity	14.	Recreation and Education: Number of Formal Education Visits per Child Below 16 Years to Parks with Natural Areas per Year



→ MAPPING URBAN AREAS FROM SPACE CONFERENCE 4-5 November 2015 | ESA-Esrin | Frascati, Rome (Italy)

Institutional international user organisations

User involvement

- ICLEI European Secretariat (Germany)
- ICLEI City Biodiversity Center (South Africa)
- Singapore National Parks Board
- European Environment Agency
- Convention on Biological Diversity

•I.C.L.E.I Cities Biodiversity Center



European Environment Agen







for Sustainability





User involvement



- Cities as direct beneficiaries
 - Phase 1 (prototyping): Barcelona, Tallinn, Edmonton



• Phase 2 (roll-out): 6-10 cities across the globe (currently confirmed or discussed are e.g. Addis Ababa, Lisbon, Cape Town, Lilongwe, Suwon, Kaohsiung)









General approach & timing

esa

- Phase 1 (04/2015 03/2016)
 - Requirements baseline \rightarrow finalised
 - Technical specifications \rightarrow in progress
 - Prototyping of indicators \rightarrow in progress
 - Test the use of Urban Atlas/other Copernicus data for European cities (Barcelona and Tallinn)
 - Processing of satellite images, possibly making use of local ancillary data
 - Quality control/first evaluation
 - Develop validation plan \rightarrow not started



General approach



- Phase 2 (04/2016 03/2017)
 - Roll-out of production \rightarrow Apply method to other cities
 - Validation
 - User utility assessment \rightarrow evaluation of usability and quality
 - Roll-out analysis beyond the project



Data



- SPOT-5 / TAKE 5
- Rapid Eye
- Pleiades
- •... Sentinel-2





Methodology



- Indicator 1 (natural areas)
 - Multi-temporal land cover classification
 - Integration of OSM street network
- Indicator 2 (connectivity)
 - Based on effective mesh size method by J. Jaeger
- Indicator 11 (permeability)
 - Based on Copernicus HRL imperviousness
- Indicator 12 (city trees)
 - Still on-going methodological research



First results Tallinn – Indicator 1



Land cover map





sa

First results Tallinn – Indicator 1



Candidate natural areas





sa

First results Tallinn – Indicator 11 Cesa



innovators eoforcbi

Connectivity (Indicator 2)

- New method compared to first implementations of CBI
 - Annex D of CBI User Manual
 - Based on effective mesh size → probability that 2 points randomly chosen in a landscape are in the same patch or are connected (incl. barriers and intra-patch connectivity)



Indicator 2 =
$$\frac{1}{A_{\text{total}}} (A_1^2 + A_2^2 + A_3^2 + ... + A_n^2)$$





Connectivity (Indicator 2)



esa

innovators

eoforcbi



Source: Ville de Montréal, 2011 & DMTI, 2010

Projection: NAD_1983_MTM_8

Challenges



- Definition of natural areas varies between cities and is often very much related to land use → difficult to map from satellite images
- Balancing between wishes from cities and the general nature of the CBI as an index (indicator) that is based on a standardised method and applicable world-wide
- Availability of EO time series to better discriminate vegetation types and phenological development stages → SPOT-5 Take 5 over Tallinn very helpful
- Availability of local ancillary data required for the production (e.g. land use related information, barrier data for connectivity)



Conclusions / Outlook



- Proof of concept in non-European countries
- Very high interest from city networks and individual cities
 - Baseline mapping
 - Update & monitoring
- Sentinel-2 data to overcome 2 important bottlenecks
 - Free data
 - Multi-temporal coverage



Thank you!





http://www.space4environment.com/?id=89

 MAPPING URBAN AREAS FROM SPACE CONFERENCE 4–5 November 2015 | ESA–Esrin | Frascati, Rome (Italy)

environment

4

Φ

SDa(

